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CORROSION RESISTANCE OF STAINLESS STEELS IN SEA WATER AT HIGHER TEMPERATURES

G. A. Allakhverdiev, et al

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Korrozionnaya stoykost' nerzhaveyushchikh staley v morskom vode pri povyshennykh temperaturakh

AUTHOR(S): Aliakhverdiyev, G. A., Yusifov, V. C., Efendi-Zade, S. M., and Agalarova, A. F.

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CORROSION RESISTANCE OF STAINLESS STEELS IN SEA WATER AT HIGHER TEMPERATURES

/Article by G. A. Allakhverdiyev, V. G. Yusifov, S. M. Efendi-Zade and A. F. Agalarova, Azerbaydzanskoye neftyanoye khozyaystvo, Russian, No 8, 1970, pp 47-48/

/47*

It has been known that sea water is used extensively as a cooling agent in oil refining and petrochemistry. The rather high amount of dissociated salts imparts to the water the properties of an electrolyte with high electric conductivity and strong corrosive activity.

The Caspian sea water has a total salinity of 1.0-1.5% /1/ and a typically high content of chlorine ions: Cl^{-1}, 41.67; SO_4^{--}, 23.82; HCO_3^-, 0.86; Br^-, 0.08; Na^+, 24.69; Mg^{++}, 5.66; Ca^{++}, 2.59; K^+, 0.063%.

The high content of readily adsorbed chlorine ions obviates the possibility of establishing the passivity of iron, pig iron, low-, medium-, and of even certain high-alloy austenitic steels in the sea water.

The passivity of high-alloy stainless steels in sea water depends primarily upon the content of the readily adsorbed chlorine ions.

To cite an example, the Petroleum Processing Plant imeni 22nd Congress of CPSU has been using sea water for cooling the reaction mixtures in the reactors and that the water was fed directly to the pipe system of the tubular heat exchanger. The pipes that were made from ordinary carbon steel were found to be heavily corroded (on the inner surface) and were out of commission within 6-8 months.

It was also revealed that the pipe resistance was unaffected by the reaction mixture consisting of oil distillate, isopropyl alcohol, and carbamide. To extend the service life of the reactors, the carbon-steel pipes were replaced with pipes from Kh18N10T stainless steel. It is a matter of general experience, however, that the activating effect of chlorine ions causes pitting (as deep as 1.75 mm/year) in some 18-8 grade stainless steels subjected to service in sea water /2/.

To select reactor pipe materials with higher resistance to corrosion, /48*
a series of tests was conducted on Kh18N10T, St-3, Kh18N9, Kh17N2, Kh17N13M2T, and OKh23N28M3D3T steels. The specimen preparation included grinding with fine emery cloth, degreasing with alcohol and holding in the desiccator for 24 hours.

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*Numbers in the margin indicate pagination in the original foreign text

The tests were conducted at 60, 80 and 90°C, to match heat exchange temperatures in the reactors, and at mixture flow rates of 1.5-2 m/sec.

(1)	(2)				
St-3	23	3,6	53	(3)	
Kh18N10T	—	—	—	0,01	0,013
Kh17N13M2T	—	—	—	—	0,012

1)--steel grade; 2)--mean penetration depth of corrosion at cited test temperatures; 3)--not tested

The corrosion rates were determined on the basis of weight loss tests for a duration of seven hours. On completing of testing, the specimens were held in inhibited hydrochloric acid (sufficiently long to remove the corrosion spots), brushed off with alcohol, held for some time in the dessicator and weighed. Both the rate and mean corrosion depth were determined from the difference in weight.

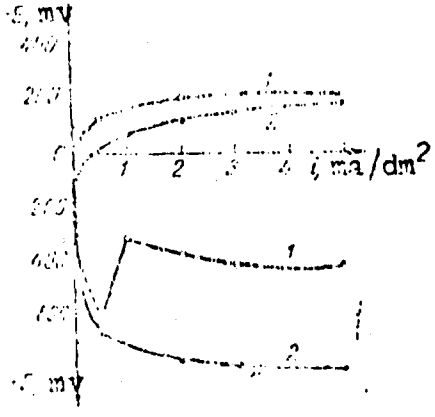

Fig. 1

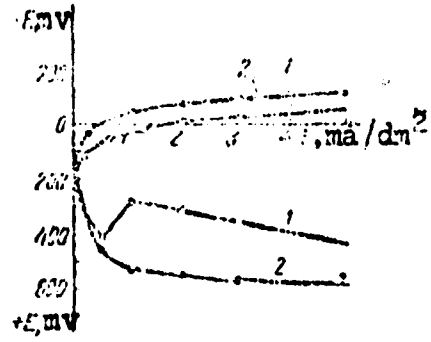

Fig. 2

The test results which are cited in a table show that stainless steels alloyed with molybdenum and Kh18N10T steel were affected by corrosion only slightly. St-3 carbon steel was affected to a greater degree and OKh23N28M3D3T steel was unaffected by corrosion at either test temperature.

The above stainless steels were also tested for resistance to pitting. Thoroughly ground specimens of the steels were tested for 400 hours. A visual examination of the surface failed to detect any traces of pitting corrosion on Kh17N13M2T and OKh23N28M3D3T steels. The surface of K18N10T specimens was covered with clearly visible pitting marks resulting from the activating effect of chlorine ions on the steel surface /3,4/. The surface potential of the pitting-metal

pair is known to be as high as 0.5-0.6 v which is conducive to rapid advancement of pitting into the metal's depth /5/.

Chromium-nickel steels, containing more than 2% molybdenum, have shown high resistance to corrosion as confirmed by tests on specimens from steels additionally alloyed with molybdenum (Kh17N13M2T--1.8-2.5% Mo; OKh23N28M3D3T--2.5-3.5% Mo).

The resistance of stainless steels to pitting corrosion was also confirmed by electrochemical measurement data. The electrochemical tests included Kh17N2 steel as well.

Polarization curves based on galvanostatic measurements are shown in Figs 1 and 2.

According to these curves an increase in superposed current density in Kh17N2 and KhN10T steels (Fig. 1) shifts the anodic potential toward the positive side (more pronounced for Kh18N10T than for Kh17N2). As the density current exceeds 0.5 ma/dm^2, the electrode potential oscillates within 0.5 v for Kh18N10T and within 0.15 v for Kh17N2 steel.

The polarization curves of Kh17N13M2T and OKh23N28M3D3T steels (Fig. 2) did not show any fluctuation which indicates the much higher resistance of these steels to the activating effect of chlorine ions.

CONCLUSIONS

The corrosion rate of carbon steels increases with the temperature of the medium.

Because of the activating effect of chlorine ions, the corrosion resistance of 18-8 and Kh17N2 stainless steels at higher temperatures and relatively higher flow velocities is characterized by a marked narrowing and reduction of the passivity region, which results in localized corrosion.

Under the above testing conditions chromium-nickel austenitic steels that are additionally alloyed with molybdenum are quite resistant both to total and localized corrosion.

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